

## Title:

Drilling Systems Automation (DSA) Roadmap - Phase II, Stage I full report

## Submitted by:

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## Principal Investigators(s):

John de Wardt, Program Manager. Will undertake the primary workload to coach, develop and write up the Phase II, Stage I report.

Other participants on a volunteer basis include:

Mark Andersen (Shell), Eric Cayeux (IRIS), Amanda DiFiore (Circadian), Blaine Dow (Schlumberger), Clay Flannigan (SWRI), Slim Hbaieb (Schlumberger), Calvin Inabinett (formerly Aerospace Rocketdyne), Moray Laing (SAS / SPE DSATS), Terry Loftis (Transocean / IADC ART), Robin Macmillan (NOV), John Macpherson (Baker Hughes / SPE DSATS), Chris Mailey (AUVSI), Bob Moran (Halliburton), Randy Mutch (Ensign), Lindsay Voss (AUVSI).

External support from:

- Tom Sheridan, Ford Professor Emeritus of Engineering and Applied Psychology in the Departments of Mechanical Engineering and Aeronautics/Astronautics at MIT
- John Berra, Past Chairman Emerson Process Management
- Eric Nettleton — formerly Rio Tinto Mine of the Future™ program

## Business Impact (IMPORTANT):

The needs for an industry roadmap are compelling. The well drilling and completion industry is highly fragmented, it will require structure to enable the interoperability required to deliver functioning automated / autonomous systems. The roadmap will provide definition of supplier opportunities so they can develop applicable products and services. A transformation of this scale across our industry requires consensus on how DSA will develop in order to attract the needed levels of investment. Entry of non-oil and gas industry players will enable the industry to access alternative skills and advanced technologies necessary for accelerating successful adoption. Fear of change to technologies and personnel is high and can be overcome through a clearly communicated comprehensive way forward.

Communicating the business value that DSA can deliver is a key hurdle to implementation. Currently, results have shown improvements in terms of rate of penetration (40% over human driller rotary drilling), building and steering wells (80% improvement while sliding) however the overall value proposition is larger. A recent offset industry example has demonstrated that when port container handling lift equipment was automated, with supervisory remote control, the whole wharf system became automated. The impact was an increase productivity by 18%, reduced maintenance by 27% and reduced fuel consumption / emissions by 22%. Similar system value can occur in applying a comprehensive DSA to the benefit of operators, drilling contractors and service companies.

## Technical Objectives:

Stage I Report: This will be the first fully developed report from all the challenges identified to achieve DSA. It will be the input to the full review and consultation cycle with the industry intended to occur in Stage II.

A comprehensive Drilling Systems Automation Roadmap (DSA-R) that describes the next 10 years of potential development is a highly valuable document for the upstream oil industry. There is a significant desire to realize value for drilling systems automation. Specific applications have been successful for both operators and suppliers. However, the development of an overall integrated application between various companies appears too complex to achieve in the near term.

The oil and gas industry is fragmented in structure creating a difficult environment in which to adopt industrial automation. There is a degree of fear over the application of automation including a lack of understanding of what it is, a lack of definition on how it will function, minimal rewards for implementation and the threat to employment of individuals leading to lost revenues.

Furthermore, the managers who control the investment in new DSA technology and business processes have no clear description of what it is and how it can deliver value to them.

This roadmap will support a consensus on a set of needs leading to the developments required to satisfy those needs; it will provide a mechanism to help forecast how these developments will progress and provide a framework to coordinate between disparate players. It will enable non-oil and gas industry players with applicable expertise to envision how they can contribute to the implementation of drilling systems automation.

## Methodology:

The founders of the DSA-R undertook a review of roadmaps and roadmapping processes in domains considered to be similar to Drilling Systems Automation (DSA). The roadmapping process developed and published by Sandia National laboratories, for unlimited release, was found to be the most

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 appropriate example for adoption for the DSA Roadmapping process. In fact, it forms the basis of the version in Wikipedia and is the similar format to that adopted by IEA in their guide to energy technology roadmaps.

The DSA-R process description document was developed from the Fundamentals of Technology Roadmapping report issued by the Strategic Business Development Department, Sandia National Laboratories. Authors: Marie L. Garcia & Olin H. Bray; SAND97-0665 - Unlimited Release by John de Wardt and reviewed by Ed Tovar & Daniel Declute-Melacon (the three founders).

The steering committee was formed by the founders; this met repeatedly to develop the foundation and then the challenges. The meetings were all held via video conference coordinated by the program manager using GoToMeeting. As a result of a company re-assignment, Daniel Declute-Melacon dropped out of the program. John de Wardt took the role of program manager as he had been leading the process and Ed Tovar the role of deputy program manager.

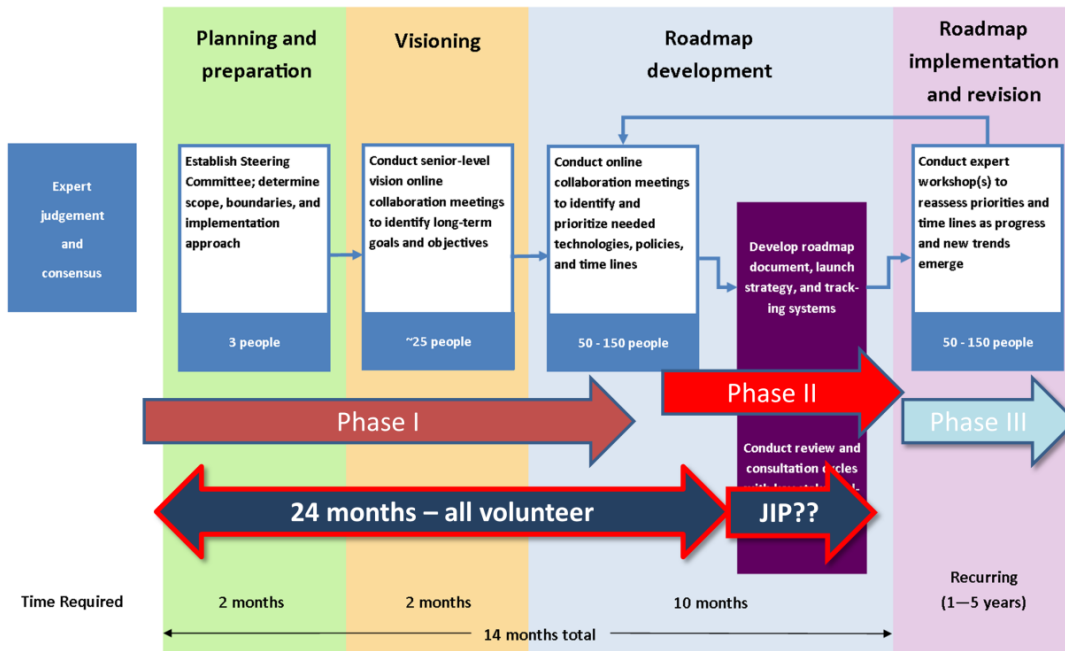


Figure 1 – DSA – Roadmap Phases based on Sandia national Labs Roadmap Process

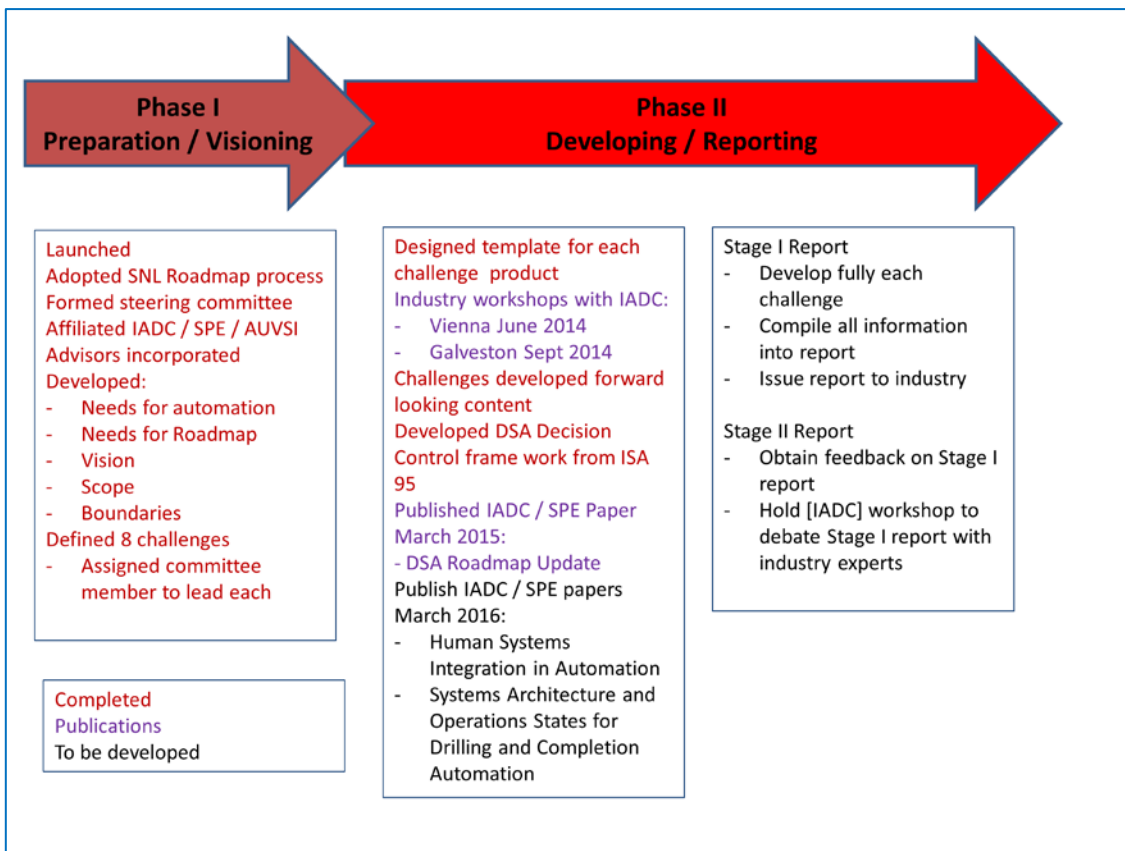


Figure 2 – DSA – Roadmap Phases based on Sandia national Labs Roadmap Process

## Phase I: Foundation Phase

Summary of Phase I of the DSA-R Industry Initiative.

- Launched this all volunteer initiative June 2013.
- Identified the Sandia National Labs Technology Roadmap process as the best to adopt and adapted it to our purpose.
- Formed a committee of industry experts covering the necessary range of skill sets (listed below).
- Affiliated to IADC ART, SPE DSATS and AUVSI (Association of Unmanned Vehicle Systems International).
- Operate in the virtual world using video conferences, web, e-mail.
- Brought on board two key, experienced advisors (listed below).
- Developed the needs, visions and boundaries
- Defined 8 key challenges that require mapping to effectively describe the future potential implementation of DSA-R. Listed below.
- Assigned a committee member to lead each key challenge; built sub teams to work on each with more industry experts – currently around 50 people involved.

## Phase II: Development Phase

The challenge teams worked under the guidance of the program manager and the steering committee to develop their outlooks. Progressively, each challenge team reported back to the steering committee with each progressing at various rates of progress.

This phase commenced interaction and publication to the industry.

- Held workshops through IADC at IADC World Drilling (69 attendees) in Vienna and IADC ART Conference Galveston (133 attendees) in 2014. Both very well received.
- Published IADC / SPE Paper at 2015 Drilling Conference in London titled: Drilling Systems Automation Roadmap - The Means to Accelerate Adoption. This was the #1 ranked abstract of 504 abstracts submitted for this conference.
- Two additional papers will be published at the 2016 IADC / SPE Drilling conference covering two key challenges (the abstracts for these papers ranked #2 and #4 respectively of 356 abstracts):
  - Human Systems Integration.
  - Systems Architecture and Operations States for Drilling and Completion Automation.

The very high ranking of the DSA-R abstracts in the IADC / SPE Drilling Conferences ranking is a demonstration of very strong industry interest in this work and quality deliverables by the DSA-R committee.

The 2015 publication included a first of its kind adaption of the ISA-95 hierarchical abstract model of the enterprise for drilling, including control functions and business functions, and its information exchange combined with the manufacturing execution system adaption of ISA-95, creating DSA - Drilling Systems Automation Decision Making and Control Framework.

Phase II requires more work to detail out the story line for each of the key challenges, identify key target applications (deep offshore versus shale drilling on land) and describe key technology / methodology alternatives and timelines.

This phase compiles the roadmap report and is the first whole publication to present to the industry.

### Stage I Report

This will be the first fully developed report from all the challenges. It will be the input to the full review and consultation cycle with the industry intended to occur in Stage II.

### Stage II Report

This report will be an update of Stage I report and consider all the feedback solicited via multiple means from the industry – uploaded comments, video conferences and an in person workshop. This critical workshop could be scheduled for mid-2016 in Houston and we would ask IADC to organize it on behalf of the DSA-R initiative.

## Phase III: Implementation and Revision

This phase has not been defined currently. It will continue to follow the Sandia National laboratories Roadmapping process.

## Deliverables:

The DSA-R initiative intends to develop a series of reports that detail the expected progression of drilling systems automation over the next 10 years – to 2015. The deliverable from this JIP is the Phase II, Stage I report described above.

### Structure of the Phase II, Stage I Report

The report will be structured according to best practices in major industry roadmaps and the Sandia National Laboratories process.

1. Executive Summary
2. Purpose, Scope and boundaries
3. Needs for automation / needs for a roadmap
4. Vision, Define the product
  - 4.1. Land multiple wells & offshore exploration
5. Current State
6. Describe development in terms of systems architecture and 7 challenges (major technology areas)
  - 6.1. Functional description / performance targets / current situation / problem statement / way ahead
7. Represent graphically in a map
8. Value proposition for integrated development of Drilling Systems Automation Roadmap

### Scope of Work for Phase II, Stage I Report

Pricing has been developed to:

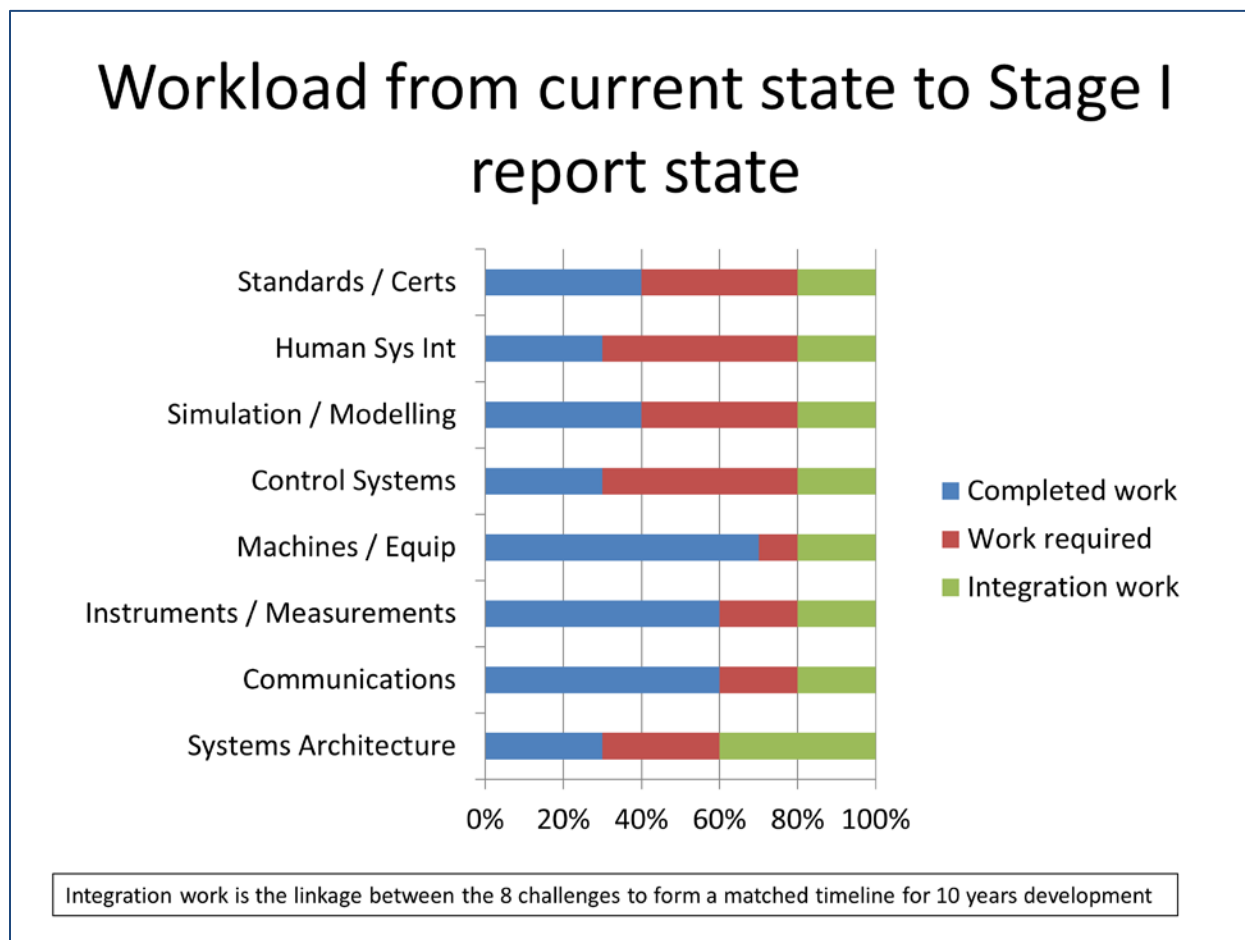
- Coach / support challenge teams that are behind on delivery
- Integrate challenge team time lines and highlight interdependencies
- Facilitate online meetings to keep committee in full endorsement
- Draft Stage I report, review with committee and issue for industry review

The quoted pricing has been developed based on:

- Industry consultant John de Wardt (special discounted rate for non-commercial work) - \$80,000
- Ad hoc specialist consultant support (such as Tom Sheridan) for some expert input - \$10,000
- Expenses – primarily trip(s) to Houston to present the output - \$5,000

Total cost for Phase II, Stage I report due six months after funding approved - \$95,000

The workload required to complete the Stage I report is shown graphically below. Some challenges require significant effort to perform work / lead the teams to develop their future outlook and, thereafter, the integration process will be undertaken to balance the technologies / timelines in the challenges.



Funding companies will be offered a half day interactive session in Houston, Tx with employees explaining details of the report – these events to be scheduled into a single trip for cost effectiveness.

## Startup Date:

Project for the Phase II, Stage I can start within 30 days of confirmed funding.  
The original work started in June 2013.

### **Project Duration:**

The duration of the work for the Phase II, Stage I report is estimated at 6 months.

### **Project Cost:**

The quoted pricing to achieve the Phase II, Stage I report has been developed based on:

- Industry consultant John de Wardt (special discounted rate for non-commercial work) - \$80,000
- Ad hoc specialist consultant support (such as Tom Sheridan) for some expert input - \$10,000
- Expenses – primarily trip(s) to Houston to present the output - \$5,000

Total cost for Phase II, Stage I report due six months after funding approved - \$95,000

### **Cost Per Participant:**

The proposal is to attract 10 companies to invest at \$10,000 each creating \$100,000 funding which is the estimated cost plus contingency for further support to funding members.